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10/772,893	02/04/2004	Pravin K. Narwankar	008209	5371

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APPLIED MATERIALS, INC.  
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EXAMINER

STOUFFER, KELLY M

ART UNIT	PAPER NUMBER
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1762

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PAPER

**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

<p align="center"><b>Office Action Summary</b></p>	<b>Application No.</b> 10/772,893	<b>Applicant(s)</b> NARWANKAR ET AL.	
	<b>Examiner</b> Kelly Stouffer	<b>Art Unit</b> 1762	

**-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --**

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 04 February 2007.
- 2a) ☐ This action is **FINAL**.                      2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1-32 is/are pending in the application.
- 4a) Of the above claim(s) 23 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-22 and 24-32 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☒ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).  
a) ☐ All    b) ☐ Some \*    c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- |   |   |
|---|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)   | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)  | 5) <input type="checkbox"/> Notice of Informal Patent Application                       |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08)<br>Paper No(s)/Mail Date <u>3/15/04 10/22/04 6/30/05</u> . | 6) <input type="checkbox"/> Other: _____  |

## DETAILED ACTION

### *Election/Restrictions*

1. Restriction to one of the following inventions is required under 35 U.S.C. 121:

- I. Claims 1-22 and 24-32, drawn to a method, classified in class 427, subclass 376.2.
- II. Claim 23, drawn to a product, classified in class 428, subclass various.

The inventions are distinct, each from the other because of the following reasons:

Inventions in groups I and II are related as process of making and product made.

The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make another and materially different product or (2) that the product as claimed can be made by another and materially different process (MPEP § 806.05(f)). In the instant case the process as claimed could be used to create a film with uniform nitrogen concentration and the film can be made by any process, including ALD or CVD techniques.

Because these inventions are independent or distinct for the reasons given above and there would be a serious burden on the examiner if restriction is not required because the inventions have acquired a separate status in the art in view of their different classification, restriction for examination purposes as indicated is proper.

Because these inventions are independent or distinct for the reasons given above and there would be a serious burden on the examiner if restriction is not required

because the inventions require a different field of search (see MPEP § 808.02), restriction for examination purposes as indicated is proper.

During a telephone conversation with Robert Bernadicou on 10 September 2007 a provisional election was made with traverse to prosecute the invention of group I, claims 1-22 and 24-32. Affirmation of this election must be made by applicant in replying to this Office action. Claim 23 is withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. Any amendment of inventorship must be accompanied by a request under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

### ***Oath/Declaration***

2. The oath or declaration is defective. A new oath or declaration in compliance with 37 CFR 1.67(a) identifying this application by application number and filing date is required. See MPEP §§ 602.01 and 602.02.

The oath or declaration is defective because:

Non-initialed and/or non-dated alterations have been made to the oath or declaration. See 37 CFR 1.52(c).

***Specification***

3. The disclosure is objected to because of the following informalities: On line 1, paragraph 0038, "Figure 5" should be "Figures 5A-5C".

Appropriate correction is required.

***Claim Rejections - 35 USC § 102***

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

4. Claims 1-17 and 24-32 are rejected under 35 U.S.C. 102(e) as being anticipated by US Patent Publication 2002/0197884 A1 to Niimi et al.

As to claim 1, Niimi et al. discloses a method of forming a dielectric film comprising incorporating nitrogen into a dielectric film using a nitridation gas and a RTP anneal (paragraphs 0033-0040) wherein a pressure of less than about 10 torr is used for the RTP anneal. (paragraphs 0048, 0052, 0555)

As to claim 2, the nitrogen concentration peaks at the surface of the film as it is incorporated into the film (paragraphs 0033-0040 and see top surface nitridation in paragraph 0046).

As to claim 3, the nitrogen concentration is equal or greater than 5 % (Figures 6 and 7)

As to claim 4, the film is less than or equal to 12 angstroms (paragraph 0033).

As to claim 5, the nitridation gas is ammonia, nitric oxide or nitrous oxide (paragraph 0034).

As to claim 6, the dielectric is silicon dioxide (paragraph 0033).

As to claim 7, silicon oxynitride is formed (paragraph 0042).

As to claim 8, Niimi et al. discloses forming a gate stack comprising forming silicon dioxide on a substrate, the process of claim 1 as discussed above, continuing the RTP anneal until silicon oxynitride is formed with nitrogen of about or more than 5% (Figures 6 and 7), and forming a cap layer on the silicon oxynitride (paragraph 0043).

As to claim 9, the RTP process occurs at 900-1100°C (abstract).

As to claim 10, a post annealing process occurs at 1000-1100°C (paragraph 0048, the re-oxidation process).

As to claim 11, the post annealing occurs at less than or equal to 5 torr (paragraph 0048).

As to claim 12, Niimi et al. includes the provisions of the process as discussed in claim 1 and a post annealing process (paragraph 0048).

As to claim 13, the nitrogen concentration peaks at the surface of the film as it is incorporated into the film (paragraphs 0033-0040 and see top surface nitridation in paragraph 0046).

As to claim 14, the nitrogen concentration is equal or greater than 5 % (Figures 6 and 7)

As to claim 15, the film is less than or equal to 12 angstroms (paragraph 0033).

As to claim 16, the nitridation gas is ammonia, nitric oxide or nitrous oxide (paragraph 0034).

As to claim 17, the dielectric is silicon dioxide (paragraph 0033).

As to claims 24-31, the limitations are disclosed as discussed above.

As to claim 32, the silicon oxynitride is post-annealed in a non-nitridation atmosphere (paragraph 0048, it is a reoxidation atmosphere).

5. Claims 1-17 and 24-31 are rejected under 35 U.S.C. 102(e) as being anticipated by US Patent Publication 2004/0002226 A1 to Burnham et al.

As to claim 1, Burnham et al. discloses a method of forming a dielectric film comprising incorporating nitrogen into a dielectric film using a nitridation gas and a RTP anneal (abstract) wherein a pressure of less than about 10 torr is used for the RTP anneal (Chart II).

As to claim 2, the nitrogen concentration peaks at the surface of the film as it is incorporated into the film (Figure 10).

As to claim 3, the nitrogen concentration is equal or greater than 5 % (paragraph 0018).

As to claim 4, the film is less than or equal to 12 angstroms (paragraph 0024 and Chart II).

As to claim 5, the nitridation gas is ammonia, nitric oxide or nitrous oxide (paragraph 0017).

As to claim 6, the dielectric is silicon dioxide (paragraph 0017).

As to claim 7, silicon oxynitride is formed (paragraph 0018).

As to claim 8, Burnham et al. discloses forming a gate stack comprising forming silicon dioxide on a substrate, the process of claim 1 as discussed above, continuing the RTP anneal until silicon oxynitride is formed with nitrogen of about or more than 5% (paragraph 0018), and forming a cap layer on the silicon oxynitride (paragraphs 0019-0020).

As to claim 9, the RTP process occurs at 900-1100°C (Chart II).

As to claim 10, a post annealing process occurs at 1000-1100°C (paragraph 0019, RTCVD).

As to claim 11, the post annealing occurs at less than or equal to 5 torr (paragraph 0019, LPCVD).

As to claim 12, Burnham et al. includes the provisions of the process as discussed in claim 1 and a post annealing process (paragraphs 0019-0020).

As to claim 13, the nitrogen concentration peaks at the surface of the film as it is incorporated into the film (Figure 10).



As to claim 14, the nitrogen concentration is equal or greater than 5 % (paragraph 0018).

As to claim 15, the film is less than or equal to 12 angstroms (paragraph 0024 and Chart II).

As to claim 16, the nitridation gas is ammonia, nitric oxide or nitrous oxide (paragraph 0017).

As to claim 17, the dielectric is silicon dioxide (paragraph 0017).

As to claims 24-31, the limitations are disclosed as discussed above.

6. Claims 1-2, 4-7, 12-13, 15-17, 24-27 and 30 are rejected under 35 U.S.C. 102(b) as being anticipated by WO99/043023 to Benashel et al.

US Patent 6372581 to Benashel et al. is used as a translation of WO99/043023 for the purposes of this rejection as it is a 35 USC 371 application of WO99/043023.

As to claim 1, Benashel et al. discloses a method of forming a dielectric film comprising incorporating nitrogen into a dielectric film using a nitridation gas and a RTP anneal wherein a pressure of less than about 10 torr is used for the RTP anneal (abstract).

As to claim 2, the nitrogen concentration peaks at the surface of the film as it is incorporated into the film (Figure 3).

As to claim 4, the film is less than or equal to 12 angstroms (column 3 et seq.).

As to claim 5, the nitridation gas is ammonia, nitric oxide or nitrous oxide (column 3 et seq.).

As to claim 6, the dielectric is silicon dioxide (column 2 lines 60-67).

As to claim 7, silicon oxynitride is formed (column 2 lines 60-67).

As to claim 12, Benashel et al. includes the provisions of the process as discussed in claim 1 and a post annealing process (column 3 lines 1-5).

As to claim 13, the nitrogen concentration peaks at the surface of the film as it is incorporated into the film (Figure 3).

As to claim 15, the film is less than or equal to 12 angstroms (column 3).

As to claim 16, the nitridation gas is ammonia, nitric oxide or nitrous oxide (column 3).

As to claim 17, the dielectric is silicon dioxide (column 2 lines 60-67).

As to claims 24-27 and 30, the limitations are disclosed as discussed above.

7. Claims 1-9, 12-17, 24-28 and 31 are rejected under 35 U.S.C. 102(e) as being anticipated by US Patent 6372578 to Muramatsu.

As to claim 1, Muramatsu discloses a method of forming a dielectric film comprising incorporating nitrogen into a dielectric film using a nitridation gas and a RTP anneal (abstract) wherein a pressure of less than about 10 torr is used for the RTP anneal (column 5 lines 20-30).

As to claim 2, the nitrogen concentration peaks at the surface of the film as it is incorporated into the film (Figure 5).

As to claim 3, the nitrogen concentration is equal or greater than 5 % (column 6 lines 40-55).

As to claim 4, the film is less than or equal to 12 angstroms (column 6 lines 40-55).

As to claim 5, the nitridation gas is ammonia, nitric oxide or nitrous oxide (abstract).

As to claim 6, the dielectric is silicon dioxide (abstract).

As to claim 7, silicon oxynitride is formed (abstract).

As to claim 8, Muramatsu discloses forming a gate stack comprising forming silicon dioxide on a substrate, the process of claim 1 as discussed above, continuing the RTP anneal until silicon oxynitride is formed with nitrogen of about or more than 5% (column 6 lines 40-55), and forming a cap layer on the silicon oxynitride. (columns 3-4 lines 33-3)

As to claim 9, the RTP process occurs at 900-1100°C (column 5 lines 5-20).

As to claim 12, Muramatsu includes the provisions of the process as discussed in claim 1 and a post annealing process (columns 3-4 lines 33-3).

As to claim 13, the nitrogen concentration peaks at the surface of the film as it is incorporated into the film (Figure 5).

As to claim 14, the nitrogen concentration is equal or greater than 5 % (column 6 lines 40-55).

As to claim 15, the film is less than or equal to 12 angstroms (column 6 lines 40-55).

As to claim 16, the nitridation gas is ammonia, nitric oxide or nitrous oxide (abstract)

As to claim 17, the dielectric is silicon dioxide (abstract).

As to claims 24-28 and 31, the limitations are disclosed as discussed above.

### ***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
  2. Ascertaining the differences between the prior art and the claims at issue.
  3. Resolving the level of ordinary skill in the pertinent art.
  4. Considering objective evidence present in the application indicating obviousness or nonobviousness.
8. Claims 10, 11, 29, 30 and 32 are rejected under 35 U.S.C. 103(a) as being unpatentable over Burnham et al. or Benashel et al. or Muramatsu in view of Niimi et al. Burnham et al. or Benashel et al. or Muramatsu include the limitations of claims 10, 11, 29, 30 and 32 as discussed above except for using annealing in a non-nitridation atmosphere as the post anneal process. Niimi et al. teaches a post anneal annealing process under re-oxidizing conditions to reduce defect density of the layer and improve

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channel carrier mobility (also see process parameters as discussed above for this process in Niimi et al.).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Burnham et al. or Benashel et al. or Muramatsu to include a post anneal annealing process under re-oxidizing conditions as taught by Niimi et al. in order to reduce defect density of the layer and improve channel carrier mobility.

9. Claims 18-23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Niimi et al., Burnham et al., Benashel et al. or Muramatsu in view of US Patent Publication 2002/0119674 A1 to Thakur.

Niimi et al., Burnham et al., Benashel et al. or Muramatsu disclose the limitations claims 18-23 as discussed above except for using a cluster tool in the manner claimed. Thakur teaches clustering various steps in a similar process in the manner claimed in order to reduce contamination in the oxide and other layers (paragraphs 0008 and 0034).

It would have been obvious to modify either Niimi et al., Burnham et al., Benashel et al. or Muramatsu to include using a cluster tool in the manner claimed as taught by Thakur in order to reduce contamination in the oxide and other layers.

**Conclusion**

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Kelly Stouffer whose telephone number is (571) 272-2668. The examiner can normally be reached on Monday - Thursday 7:00-5:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Timothy Meeks can be reached on (571) 272-1423. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

kms

Kelly Stouffer  
Examiner  
Art Unit 1762



**TIMOTHY MEEKS**  
**SUPERVISORY PATENT EXAMINER**